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(54) Abstract Title
Fluid transfer system

(57) An apparatus for transferring fluid between two structures, which may be either an oil rig 22 and a ship 11 or two ships 11, comprises a rigid transfer arm 29,30 which is pivotally attached 26 to the first structure 22 for movement about at least two pivot axes, and defines a fluid conduit for transfer of the fluid between the two structures 11,22. The arm 29,30 extends between the two structures 11,22 while floating on the surface of the water, and may be provided with buoyancy aids. The arm is preferably in two parts 29 and 30, one part 29 being a floating pier, and the other part 30 being a connecting arm to the first structure 22. Thrust means may be attached to the free end of the rigid arm in order to rotate the arm about a vertical axis. The connecting arm 30 is preferably in the form of a space frame construction (13; figure 2), the fluid conduit (16; figure 2), which may be surrounded by insulation, being located inside one part (14; figure 2) of this construction.

FIG 5

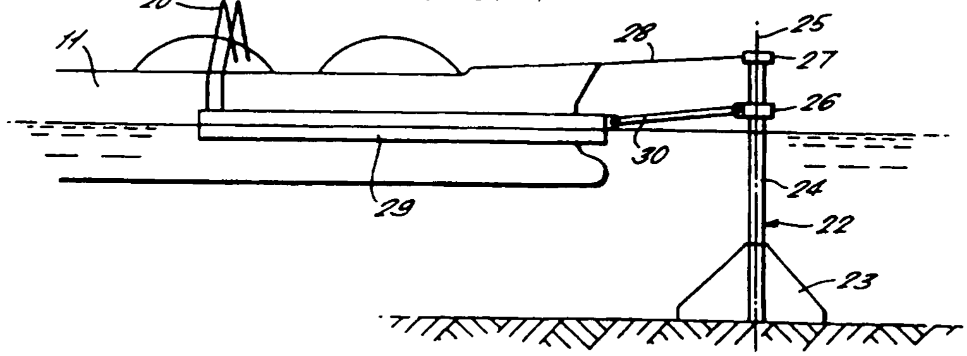

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FIG. 1.

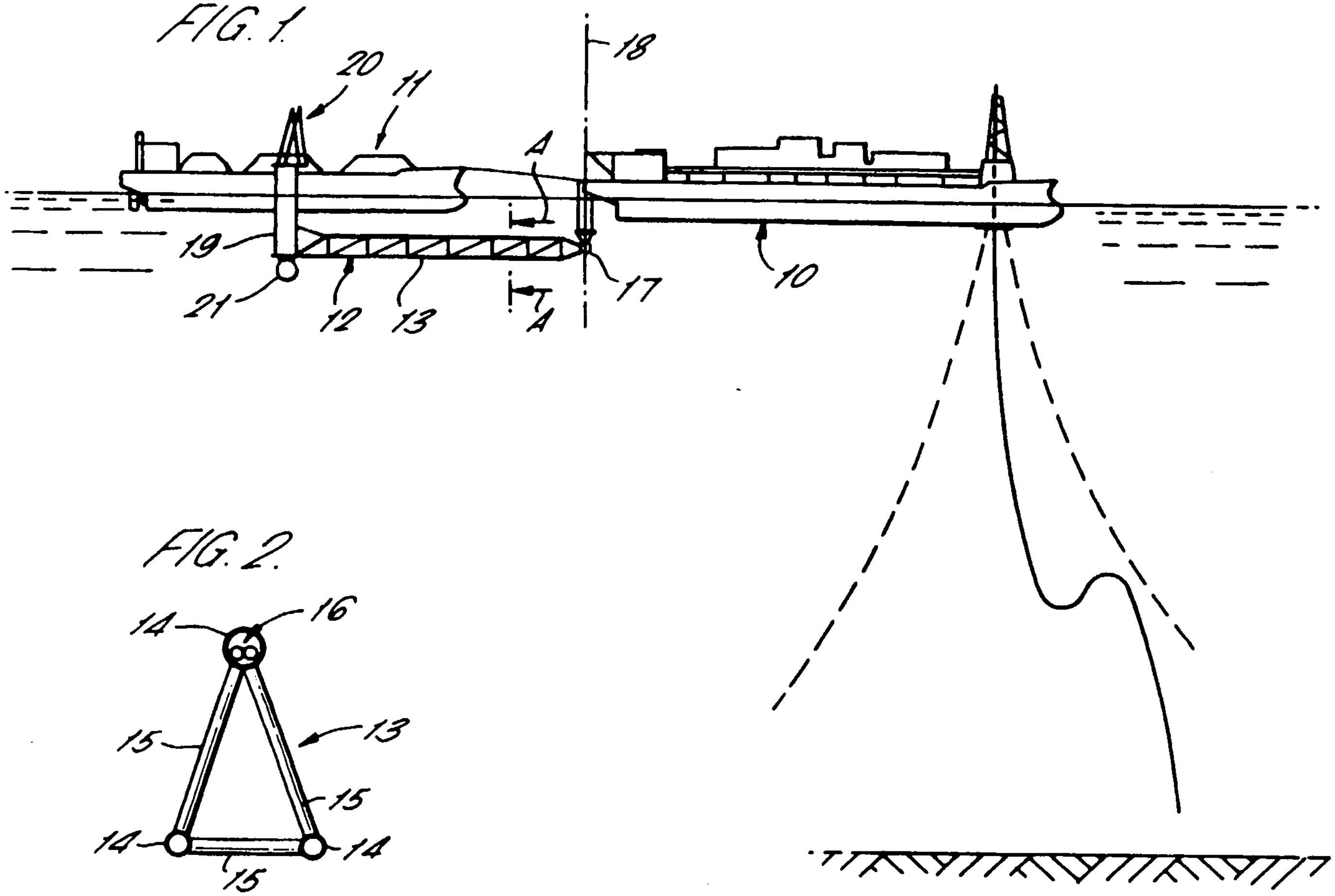


FIG. 2.

FIG. 3.

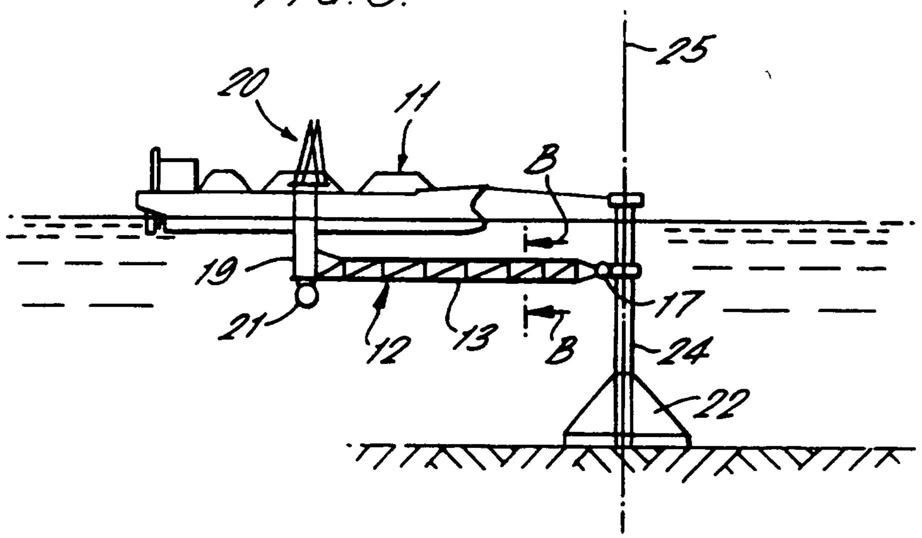
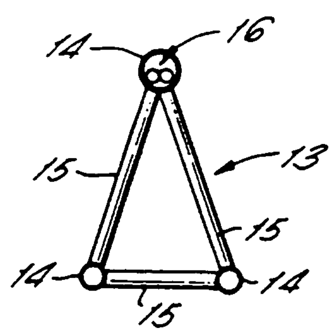


FIG. 4.



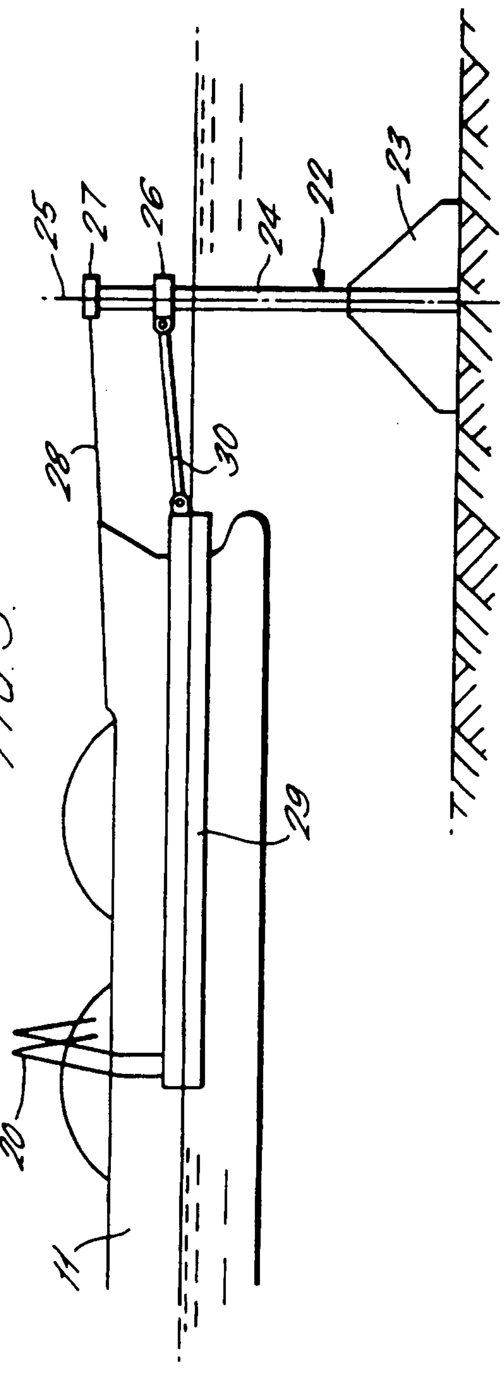


FIG. 5.

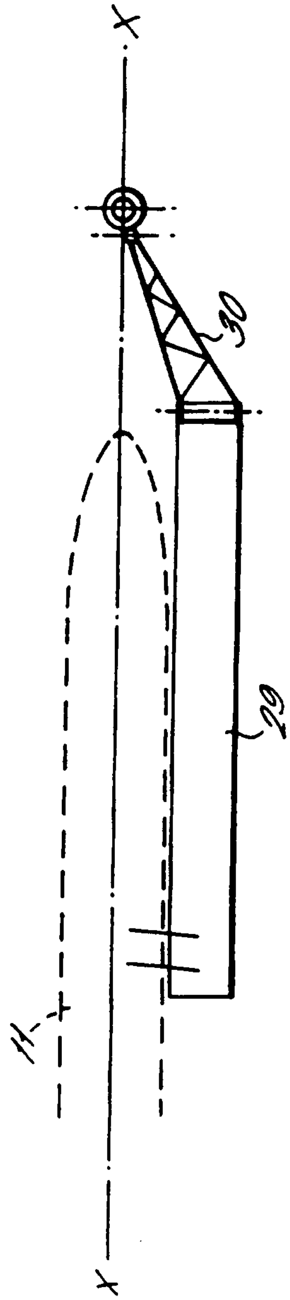


FIG. 6.

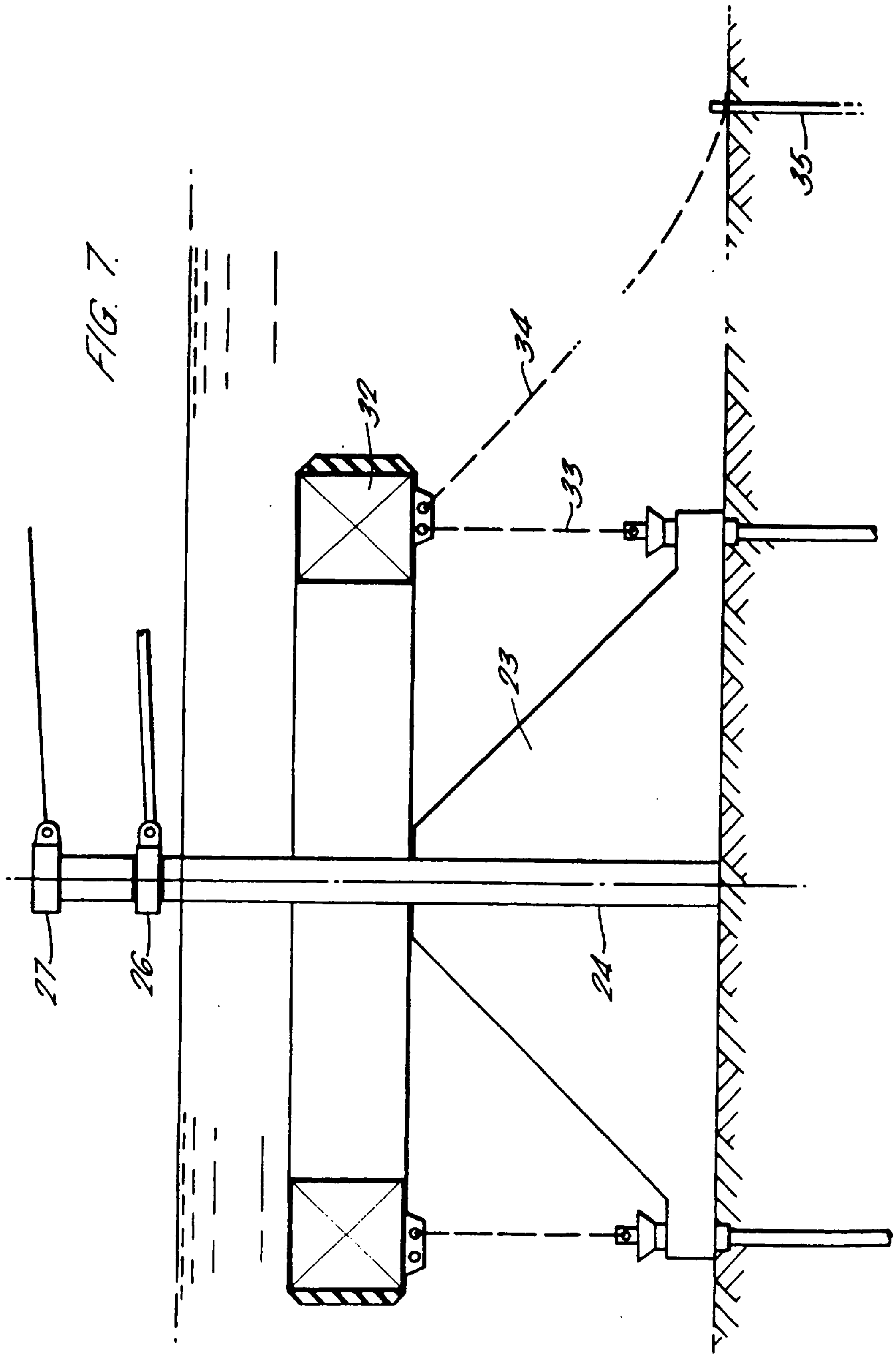


FIG. 7.

FLUID TRANSFER SYSTEM

The present invention relates to apparatus for transferring fluid between two floating vessels. This application is divided from GB 9805813.4 which is directed to a fluid transfer apparatus comprising a rigid arm movable by thrusters.

As a by-product of offshore oil production operations, a large quantity of gas is usually generated. In order to avoid having to flare this gas off into the atmosphere, it is often desirable to cool it down into liquid form and store it for later transport. A major problem is that the conventional technology for transferring fluid between ships, ie. using flexible hoses, cannot be used for transferring liquid natural gas because of the very low temperatures involved.

Also, when loading liquid natural gas at remote locations, for example where a liquefaction plant is located onshore but a vessel's loading terminal is some miles offshore due to the lack of a natural or man-made harbour, it is a requirement to obviate the need for flexible hoses which are commonly used in current offshore loading terminals.

It is the object of the present invention to provide a practical system for transferring fluid between vessels, such as a production or storage vessel and a shuttle tanker, or for transferring fluids between a pipeline on the seabed, originating from onshore based plant, and a shuttle tanker, which obviates the need for flexible hoses.

Accordingly, the present invention provides apparatus for transferring fluid between two structures, comprising a rigid transfer arm defining a fluid conduit for receiving fluid from a first structure, means to attach a first end of the arm to the first structure so as to allow the arm to pivot about at least two axes, and loading means located at the second end of the arm and attachable to a second structure for transferring fluid from the fluid conduit to the second structure, wherein the transfer arm extends between the first and second structures floating on the surface of the water.

In a first embodiment, the first and second structures comprise floating vessels.

In a second embodiment, the first structure is mounted on the seabed and extends therefrom to above the surface of the water and the second structure comprises a floating vessel.

Preferably, the attachment means allows the arm to pivot about a vertical axis in use.

Thrust means may be attached to the second end of the arm to rotate the arm about the vertical axis.

Conveniently, the arm is a space frame construction having a plurality of longitudinal members joined by a plurality of transverse bracing members.

In this case, the fluid conduit may be located inside one of the longitudinal members, insulation may be provided around the fluid conduit and the fluid

conduit may be provided with swivel joints to allow it to bridge the pivot points in the apparatus.

The rigid transfer arm is ideally provided with buoyancy aids.

Preferably, the loading means comprises a cryogenic loading device.

In the first embodiment, the attachment means may attach the first end of the arm to the stern of the first vessel and the second end of the arm to a midship portion of the second vessel.

In the second embodiment, fendering means is preferably provided surrounding the first structure to prevent a vessel overriding the structure.

The fendering means may comprise an annular buoyant member moored to the first structure.

The invention will now be described in detail, by way of example only, with reference to the following drawings. It should be noted that only Figures 5-7 show embodiments of the invention in the drawings:

FIGURE 1 is a schematic diagram of a first device transferring fluids between two vessels;

FIGURE 2 is a cross section of the arm of FIGURE 1 along the line A-A;

FIGURE 3 is a schematic diagram of a second device for transferring fluids between a seabed pipeline and a vessel;

FIGURE 4 is cross-section of the arm of Figure 3 along the line B-B;

FIGURE 5 is a schematic diagram of a first embodiment of the invention for transferring fluid between a seabed pipeline and vessel;

FIGURE 6 is a plan view of the embodiment of Figure 5; and

FIGURE 7 shows a fendering system may be used with the embodiment of Figure 5.

Referring now to Figure 1, a first floating vessel 10 is shown, which may be a production or storage vessel moored to the seabed by any conventional and appropriate means. A second floating vessel 11, which may be a shuttle tanker for transporting fluid such as liquid natural gas away from the production/storage vessel 10, is located nearby. The transfer apparatus 12 is shown in use, connecting the two vessels 10,11.

The transfer apparatus 12 consists of a rigid arm 13, typically of space frame type construction. As shown in Figure 2, the arm 13 may be formed of three longitudinal members 14 arranged in a triangular form and joined by a number of transverse bracing members 15.

Piping 16, for example rigid steel piping, is attached to the arm and carries the fluid being transferred. The piping 16 may be located inside one or more of the longitudinal members 14 and insulation (not shown) may also be provided. This construction protects the piping 16 and allows the possibility of inspection of the piping 16.

At one end of the arm 13, attachment means 17 is provided for attaching the arm 13 to the first vessel

10. The attachment means may be constructed in any convenient form which includes articulations allowing the arm 13 to pivot about at least two axes relative to the vessel 10. One of the axes is preferably the vertical axis 18. The attachment means is sized such that the arm 13 is located underwater at a depth greater than the maximum draught of both the first and second vessels 10,11.

At the other end of the arm 13, float means 19 is provided which extends upwardly from the arm 13 and projects above the water surface.

A loading device 20, which is preferably a cryogenic loading device of known form, is located on the top of the float means 19. Articulations may be provided to allow to the loading device 20 to pivot relative to the float means 19. The loading device is connected to the piping 16 and is connectable to the second vessel 11 to allow transfer of fluid from the piping 16 to the vessel 11.

The piping 16 is provided with swivel joints where necessary to allow it to bridge the various points of articulation in the apparatus 12.

At the lower end of the float member 19, one or more thrusters 21 is located. The thruster 21 is powered and controlled from the first vessel 10.

In use, the arm 13 may be attached to the stern of the first vessel 10 and the thruster 21 is used to rotate the arm 13 about the vertical axis 18, for example to rotate it anti-clockwise if viewed from above in Figure 1, so that it does not obstruct the

area around the stern of the first vessel 10. The second vessel 11 can then be manoeuvred into position adjacent the first vessel 10 as shown in Figure 1.

Once the second vessel 11 is in position the thruster 21 is operated again to rotate the arm 13 in the opposite direction to bring the float means 19 and loading device 20 adjacent, say, the midship portion of the second vessel 11. The loading device 20 is moored to the vessel 11 and fluid from the piping 16 can be transferred to the second vessel 11. When transfer is complete, the loading device 20 is disconnected from the vessel 11 and the thruster 21 is operated to rotate the arm 13 away from the vessel 11.

A second device, for offshore loading from a seabed pipeline to a vessel, is described below with reference to Figures 3 and 4. The operating principles of this embodiment remain largely the same as for the first embodiment of Figures 1 and 2 and like reference numerals are used in Figures 3 and 4 where appropriate.

In the second device, the transfer apparatus 12, rather than being connected to a first vessel 10, is connected to a seabed mounted structure 22. This structure consists of a base 23 built on the seabed and receiving the end of a seabed pipeline (not shown) originating from, for example, onshore based plant. A column 24 rises from the base 23 to project above sea level and includes a conduit for transferring fluid from the seabed pipeline to the transfer apparatus 12.

As in the case of the first device, the transfer apparatus 12 consists of a rigid arm 13, typically of

spaceframe type construction. As shown in the sectional view of Figure 4, the arm 13 may be formed of three longitudinal members 14 arranged in a triangular form and joined by a number of transverse bracing members 15. Similarly, piping 16 is attached to the arm 13 for transferring fluid therealong and this piping 16 may be located inside one of the longitudinal members 14, possibly with insulation.

The first end of the rigid arm 13 is secured to the column 24 by attachment means 17 forming an articulated connection which allows pivotal movement of the arm 13 in the vertical plane about a horizontal axis perpendicular to the plane of the paper in Figure 3. In addition, the arm 13 is able to pivot in a horizontal plane about the vertical longitudinal axis 25 of the column 24.

At the second end of the rigid arm 13, float means 19 is provided which extends upwardly to project above the surface of the water. A loading device 20 is located on top of the float means 19, with articulations as necessary. Also as described previously, one or more thrusters 21 may be provided at the lower end of the float member 19 to allow the rigid arm to be steered towards and away from a vessel 11.

A first embodiment of the invention, also for transferring fluid between a seabed pipeline and a floating vessel is illustrated in Figure 5 and 6. In the same way as the second device above, the first embodiment of the invention includes a seabed supported structure 22, having a base 23 and upright column 24 projecting above the water surface. The

column 24 supports a first rotating table 26 and a second rotating table 27. A vessel 11 such as a shuttle tanker to be loaded with fluid from the seabed pipeline is moored by conventional means, such as a hawser 28 to the second rotating table 27.

A floating pier 29 is connected to the first rotating table 26 by means of an arm 30 with articulated connections at each end. Consequently, the floating pier 29 is able to rise and fall with sea level and is also able to rotate about the vertical longitudinal axis 25 of the column 24. As shown in the plan view in Figure 6, the connecting arm 30 may typically consist of a space frame type construction.

The floating pier 29 may be constructed of material such as steel or concrete and the water plane area may be designed such that motions of the pier 29 due to wave action is minimised. As shown in Figure 6, the pier 29 and connecting arm 30 are preferably arranged so that the pier lies offset from and parallel to an axis X of the seabed structure 22 so that the vessel 11 may be moored adjacent the pier 29 with its longitudinal axis coincident with the axis X of the seabed structure 22.

Rigid piping (not shown) is fitted between the seabed pipeline, extending up through the column 24, across the connecting arm 30, across the floating pier 29 and through the loading means 20, with articulations such as fluid swivels being provided where appropriate. Accordingly, a complete cryogenic loading system consisting of rigid piping is created.

Figure 7 shows an embodiment a fender system

which may advantageously be used in connection with the seabed structure 22 shown in Figures 3 and 5 in order to avoid the vessel 11 overriding the rigid structure 22.

In this example, the fendering system comprises an annular buoyant structure 32 anchored to the seabed at a predetermined level below the water surface by means of chains or cables 33 secured to the base 23 of the seabed structure 22. Additional catenary chains or cables 34 may be fitted between the buoyant structure 32 and anchoring points 35 on the seabed to increase the energy absorption capacity of the buoyant structure 32.

The horizontal dimensions of the buoyant structure 30 are selected such that, the vessel 11 cannot come into contact with the rigid structure 22.

Thus, the present invention provides an omproved transfer apparatus which can be used to transfer fluids such as liquid natural gas at low temperatures between two vessels or a seabed pipeline and a vessel, avoiding the need for flexible hoses. It will be apparent to those skilled in the art that a number of modifications may be made to the particular arrangements described above whilst still falling within the scope of the claims.

CLAIMS

1. Apparatus for transferring fluid between two structures, comprising a rigid transfer arm defining a fluid conduit for receiving fluid from a first structure, means to attach a first end of the arm to the first structure so as to allow the arm to pivot about at least two axes, and loading means located at the second end of the arm and attachable to a second structure for transferring fluid from the fluid conduit to the second structure, wherein the transfer arm extends between the first and second structures floating on the surface of the water.

2. Apparatus as claimed in claim 1, wherein the first and second structures comprise floating vessels.

3. Apparatus as claimed in claim 1, wherein the first structure is mounted on the seabed and extends therefrom to project above the surface of the water and the second structure comprises a floating vessel.

4. Apparatus as claimed in any preceding claim, wherein the attachment means allows the arm to pivot about a vertical axis in use.

5. Apparatus as claimed in claim 4, wherein thrust means is attached to the second end of the arm and is operable to rotate the arm about the vertical axis.

6. Apparatus as claimed in any preceding claims, wherein the arm is a space frame construction having a plurality of longitudinal members joined by a plurality of transverse bracing members.

7. Apparatus as claimed in claim 6, wherein the fluid conduit is located inside one of the longitudinal members.

8. Apparatus as claimed in claim 7, wherein insulation is provided around the fluid conduit.

9. Apparatus as claimed in any preceding claim, wherein the fluid conduit is provided with swivel joints to allow it to bridge the pivot points in the apparatus.

10. Apparatus as claimed in any preceding claim, wherein the transfer arm is provided with buoyancy aids.

11. Apparatus as claimed in any preceding claim, wherein the loading means comprises a cryogenic loading device.

12. Apparatus as claimed in claim 2, wherein the attachment means attaches the first end of the arm to the stern of the first vessel.

13. Apparatus as claimed in claim 12, wherein the loading means attaches the second end of the arm to a midship portion of the second vessel.

14. Apparatus as claimed in claim 3, further comprising fendering means surrounding the first structure.

15. Apparatus as claimed in claim 14, wherein the fendering means comprises an annular buoyant member moored to the first structure.